ASSESSING THE IMPACTS OF DEVELOPMENT CHOICES

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I. EXECUTIVE SUMMARY

This paper presents an overview of current methods and measures for evaluating the potential impacts of land use patterns. It is written to assist the Governor's Commission for a Sustainable South Florida (GCSSF), and particularly its "Full-Cost Accounting Committee," in understanding the state of the practice, for consideration of quantitative and qualitative costs and benefits that may be associated with future development in the Eastward Ho! area.
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A. Purpose and Approach of this Paper

The Governor's Commission has worked for over two years to determine ways and means of reconciling urban growth needs in South Florida with restoration of the Everglades ecosystem. Based on its intensive studies, the Commission has targeted for urban revitalization a three-county area stretching along the east coast from Miami to West Palm Beach. The Commission views the redevelopment and infill of this Eastward Ho! area as essential to reduce the continuing spread of development towards and into the Everglades.

As part of implementation of the concept of Eastward Ho!, the Commission established a "Full-Cost Accounting Committee." The Committee's charge is to identify ways to consider all potential effects of proposed development actions. These effects include secondary impacts or externalities that are frequently overlooked or discounted in impact evaluations. The Commission further charged the Committee to examine "full cost accounting" principles including social, political and ecological impacts; economic costs and benefits; legal costs; and technical feasibility. (Governor's Commission Report, p. 43.)

The Commission's charge to the Committee points toward a broad spectrum of effects that should be considered in public policy evaluations. In its discussions to date, the Committee has attempted to understand the complex interactions of potential effects, and the tools that are available or should be considered in measuring those effects.

This paper is focused on a particular aspect of the Commission's and Committee's concerns: ways to assess the impacts of various forms of development that might be considered for the Eastward Ho! Area. We present a framework for assessing and evaluating various impacts with one specific focus: patterns of land development.

Ours is a common sense or "matrix" approach. The first step in the matrix approach is to identify and list all consequences of concern for a particular policy. This is not radically different from what practitioners of cost-benefit analysis may view as identifying all costs and benefits. However, the matrix approach allows consideration of both quantitative and qualitative impacts. Restricting assessments of effects to factors that can be stated in specific monetary terms poses a number of problems.

Most importantly, it reduces the scope of analysis due to the vast number of factors that defy the price-based paradigm. Such factors include social equity, ecosystem health, aesthetics, and quality of life. Monetization is particularly problematic in cases of uncertainty, where it becomes impossible to identify and quantify all possible outcomes. In these cases, rather than placing a burden of proof on monetized "benefits" exceeding monetized costs, decision makers might want to consider the nature of the uncertainty -- and how both action and inaction present different "risks" or outcomes to society.

Our summary matrix is shown at the end of this section. In it and in this paper, we have grouped development impacts into four broad categories: economic, social, transportation, and environmental. These categories provide a useful way to consider the general implications of development, although they overlap and interact. For example, some environmental impacts can and do have economic consequences, such as destructions of habitats and species reducing tourism or opportunities for commercial and recreational fishing. However, we believe that a large number of environmental impacts defy monetization, and therefore should stand alone.

Similarly, quality of life effects can have negative economic consequences. For example, perceived decreases in public safety or the quality of public education, can lead to decreased investment in the urban core and the inner suburbs. Again, because many social impacts defy monetary expression, we list them separately.

Finally, transportation is shown as a unique category for two main reasons. First, there are a wide range of techniques and models used to conduct various types of transportation impact analysis. Second, there are significant interactions between transportation, social and environmental impacts, which are not easy to quantify or monetize.

The first two columns of the matrix list major impacts which can be attributed to changes in land use. The third column shows methods of impact measurement and/or sources of information on effects. The fourth column indicates whether or not measures can be monetized.

In the rest of this Executive Summary, each of the four groups of impacts is discussed in turn: Economic, Social, Transportation and Environmental. A more detailed discussion follows in the body of the paper, as follows: Section II., Economic; III. Social; IV. Transportation; and V. Environmental Impacts.

POSITIVE & NEGATIVE IMPACTS OF DEVELOPMENT PATTERNS

Impacts to be Evaluated	How Measured	Method of Measuremt./ Source of Information	Measures Monetized?
Economic			
	Direct Impacts: Emplymt, Income, Retail Sales, etc.	Economic Impact Analysis	Yes
	Indirect/Induced Impacts: Emplymt, Income, Sales	Economic Impact Analysis	Yes
	Costs & Revenues to Local Govts.	Fiscal Impact Analysis	Yes
Social/Quality of Life			
	Preservation of Historic & Cultural Resources	Environ. Impact Analysis; local experts/grps	Not easily
	Availability of Open Space, Parks & Recreation	Acres per 1,000 pop.; local & regional info.	Not easily
	Environmental Design	Visual Preference & other public opinion surveys	Not easily
	Availability of Affordable		

Housing

Local & Regional Information

Not easily

Equity of Development Impacts

Social Accounting Matrix; local & regional info.

Not easily

Quality of Life

Public Opinion Surveys; local & regional info.

Not easily

Transportation

VMT; LOS on Exist. Rds.; New Capacity Needed

Transportation Impact Analysis

Not easily

Environmental

Air Quality

Pollutants; Non-Attainmt. of Stds; Urban Airsheds

Not easily

Water Quality

Sediments; Turbidity Hyrdological Models

Not easily

Noise

Decibel Levels Noise Contour Analysis

Not easily

Stormwater Runoff

Volumes, Peak Discharge Computer Models

Not easily

Carrying Capacity

Water; Sewer; Landfills State, Reg. & Local Info.

Yes

Preservation of Species & Habitats

Nos. of Pop.; Acres of Habitat; Local Info.

Not easily

B. Economic Impacts

In this paper, economic impacts are discussed in two sections. Economic impacts on the public sector, commonly called fiscal impacts, are in subsection 2. below. Economic impacts on the private sector follow in subsection 1.

1. Economic Impacts on the Private Sector

Economic impacts are commonly included with environmental assessments. Stand-alone economic impact analyses are also conducted for large development projects such as sports stadiums, conference centers, and gambling casinos. Measures of economic impact include employment, income and expenditures. Direct increases in these measures due to new development are straightforward calculations using data from local, regional, state and Federal sources.

Indirect increases in these measures are usually estimated through the use of input-output models. A commonly used model, RIMSII, contains multipliers for counties, MSAs and states, based on the U.S. Department of Commerce's national input-output data. This type of analysis is most useful to compare impacts by types of jobs or industrial sectors associated with new development, or to compare different land uses on the same site. This type of economic analysis also predicts conditions at buildout of a proposed project or plan, based on existing conditions.

Indirect economic impacts can also be calculated through the use of econometric models. Such models are time-consuming and expensive to apply. However, they can account for interactions over time between growth and the economic base. What this means for Eastward Ho! is the following.

If public policies and regulations discourage new development in the outer suburbs and encourage development in existing urbanized areas, over time residential and employment locations in the urban core and inner suburbs will become more desirable. As a result, property values, household incomes and employment opportunities there will increase. An econometric model can account for such improvements, and for the redistribution of households and jobs over time. Therefore this technique is most useful to compare economic impacts of compact versus sprawl development.

2. Economic Impacts on the Public Sector

Fiscal impact analysis compares the costs of public facilities and services needed to serve new development, to the revenues generated by growth. The result of this comparison is net revenues or costs to the local government, school district, or other public entity.

Fiscal impact analysis most commonly uses the per capita method, or average costs per new resident and per job. Another technique is the case study method, in which the true marginal costs of growth are captured. This is important where the capacity of expensive public facilities such as schools is an issue.

In South Florida, a case study fiscal analysis may show cost savings for compact development due to less need for costly new infrastructure. However, using such a method, revenue projections are likely to be based on today's market values.

Due to lesser desirability of the urban core and inner suburbs as locations for new houses and jobs, lower market values there may generate lower revenues for compact development.

As with economic impact analysis, the use of econometric modeling can address this problem with fiscal analysis. That is, if new development in the outer suburbs were discouraged, market values in the inner suburbs and the urban core should increase over time. This would result in revenue projections less likely to penalize compact development vis-a-vis sprawl.

C. Social Impacts

The direct social impacts of new development are generally increases in population and employment, which are basic inputs for economic, fiscal, transportation and environmental analysis. Population and employment in turn generate demands for public facilities and services such as school buildings, teachers, and public safety personnel. Once these direct social impacts are quantified, they become inputs to fiscal impact analysis.

Some indirect social impacts are documented as part of environmental impact analysis. These include the preservation of historic and cultural resources; the availability of open space, parks and recreational facilities; the quality of environmental design; and the availability of affordable housing. These impacts are usually described based on locally available data and surveys. They may be described quantitatively but are difficult to monetize. Social impacts are most often described qualitatively.

Indirect social impacts not usually documented are issues of equity, or who wins and who loses from changes in land use. A promising, but as yet rare, technique here is to develop a "social accounting matrix." This disaggregates the results of input-output economic analysis to households and workers by race, sex, age and income.

A comprehensive analysis of social impacts would compare changes in the level of community well-being, before and after development takes place. This technique is also rarely applied, although communities are beginning to document baseline quality of life indicators. Documenting the baseline permits monitoring of change and tracking conditions in the future.

D. Transportation Impacts

Since the 1960s, the transportation impacts of both projects and plans have been analyzed using the four-step travel forecasting process. In this process, population and employment projections by geographic area or zone, are used to estimate the generation of trips. Trips are then distributed to destinations by zone. Trips are also distributed to modes, either automobile or transit. Automobile traffic is then assigned to links on the existing road network. When traffic from trips due to new development is added to existing traffic, levels of service (LOS) on existing roadways often decrease.

In addition to measures of LOS or traffic congestion, outputs of traditional transportation models include average daily trips and vehicle miles of travel. Estimates of mitigating improvements to transportation capacity (whether highways or transit) and costs of such improvements are outside traditional transportation planning models.

As with economic and fiscal models, traditional transportation models do not calculate interactions between growth and the base. Rather, they compare conditions at buildout to existing conditions. A new generation of models is attempting to integrate land use forecasting with transportation planning. That is, compact development patterns are likely to show positive transportation impacts over time. This assumes that discouragement of new development in the outer suburbs, results in more development in the inner suburbs and urban core. As higher density locations become more desirable, so should alternatives to commuting alone. The new models therefore seek to account for greater use of alternatives to single occupancy vehicle automobile trips
under compact development scenarios, by including walking, bicycling, paratransit and other options among their choices of travel mode.

Finally, data is being compiled to permit the linking of land use types, driving patterns, and automobile emissions. However, models that successfully integrate land use, transportation and air quality are not likely to be perfected for several years.

Use of current transportation models is likely to show that compact development results in lower vehicle miles of travel, fewer average daily trips, and lesser declines in LOS, especially on roadways in the outer suburbs. Compact development will also look more positive than sprawl if existing transit systems can accommodate additional trips by the greater number of households and jobs assumed to be located in the inner suburbs and urban core. Costs for significant improvements to transit, or for new systems such as light rail, can outweigh savings on roadway improvements.

E. Environmental Impacts

Environmental impact analysis became a formal discipline after passage of the National Environmental Protection Act (NEPA) in 1970. Since then, over 20 states have passed "mini-NEPAs." In Florida, environmental impacts are included in Developments of Regional Impact (DRI) analyses, and in local comprehensive plans. Although NEPA includes social, economic and other impacts, in this paper environmental impacts are focused on natural resources such as air, water, soil, species and habitats. Generally, compact development will result in lower consumption of natural resources and fewer negative environmental impacts.

In local environmental assessments, baseline conditions are documented and compared to expected future conditions after buildout of the proposed project or plan. Analysts use available data such as surveys, engineering and scientific studies, and data bases which link environmental impacts to types of land use. Comparison of baseline to future conditions is often done through the use of checklists and matrices. Another common method of comparison is through maps produced using Geographic Information Systems (GIS).

Measurements of impacts include acres of open space, wetlands, and wildlife habitats either lost or preserved; levels of pollutants in the air and water; volumes of stormwater runoff; and decibels of noise. The carrying capacity of related manmade systems, such as water, wastewater and solid waste, can also be compared to the projected demands generated by new development.

Because environmental impacts are expressed in so many different units of measurement, analysts have constructed techniques and models that attempt to weight and scale impacts in the same units of measurement, and even to assign monetary values. Such techniques and models present obstacles for decision makers in following the steps in reasoning, and in challenging the judgments involved in assigning values to environmental impacts. Evaluating the significance of environmental impacts is best done by an interdisciplinary team of professionals, working with decision makers.

F. Conclusions

Development impact analysis is an art practiced by analysts trained in a number of disciplines, and working in a number of settings. To the extent possible, this paper documents the current state of the art by such practitioners. Also to the extent possible, this paper makes conclusions about the usefulness of the various forms of analysis, to the comparison of compact and sprawl patterns of land development. The reader is referred to the matrix on page 4 for a summary of measurable impacts, and whether or not they can be monetized.

One major conclusion from this analysis is that many impacts of development cannot be easily quantified or monetized. Without "hard" numbers and absolute measures, it is still possible to assess the significance of impacts, and to compare impacts among alternatives, using qualitative measures.

It seems to these authors that decisions by both the Federal and State governments about the importance of restoring the Everglades ecosystem constitute mandates. A February 1995 report by the U.S. Army Corps of Engineers finds that, where such mandates exist, "Calculations of the monetary benefits of such actions are ... not required. The use and nonuse values of those environmental actions are implicit in the directive. Explicit monetary valuation of the benefits would be a costly ancillary exercise." (Feather et al, p. 5.)

Nevertheless, it is important to identify and evaluate potential impacts of land use patterns as one tool in decisionmaking. In South Florida, we have the opportunity to expand our knowledge and techniques in econometric modeling of economic, fiscal and transportation impacts; linking land use forecasting, transportation modeling, and air quality assessment; and documenting social impacts, including who wins and who loses under different patterns of land use.

II. ECONOMIC IMPACTS

Economic impact analyses have been conducted for over 100 years. In particular, "estimates of the econ omic benefits associated with a particular proposed action have been used as a selling point in the legislative arena" since the nineteenth century (Jain, p. 188). This is especially true for massive public works and other development projects.

For almost 60 years, a distinction has been made between economic impacts on the private sector, and economic impacts on the public sector (Muller, 1976, pp. 3-4). The latter field is generally referred to as fiscal impact analysis, and will be discussed in subsection B below.

A. Economic Impacts on the Private Sector

According to the Development Impact Assessment Handbook, most economic impact studies are part of environmental impact assessments. These assessments are undertaken when the proposed changes in land use are significant in scope. These include planned unit developments, mixed use developments, and military base closings. In some states, such as California, economic impact analysis is required as part of the General Planning process for local governments. Economic impact analysis is also conducted for large development projects such as sports stadiums, conference centers, and gambling casinos. Economic impacts are studied mainly by consulting firms and academics with backgrounds in planning, economics, business and geography. (Burchell et al, 1994, p. 107.) Economic impacts include employment, income, and expenditures generated by new development. Impacts are both direct and indirect. Direct impacts are discussed first.

1. Calculation of Direct Economic Impacts

Direct economic impacts of a project or plan include the following:

Jobs created as a result of the new development

Wages and salaries from the new jobs

Spending on personal consumption by residents of new housing units and workers in new jobs

Calculations of direct economic impacts is straightforward and can be done using available data, without the use of computer models.

2. Modeling of Indirect and Induced Impacts

Over time direct impacts bring about indirect impacts, which in turn cause induced impacts. Indirect and induced effects are calculated by means of economic impact models. Types of models are discussed below.

a. Economic Base Models

Economic base models were first developed in the 1930s to gauge the relative strength of metropolitan economies for residential mortgage underwriting. They trace the interaction of purchases by local government, households and businesses of goods and services produced by basic industries (or the export sector) and by non-basic industries (or the import sector). The impact of a dollar increase in spending at any point is traced through the cycle to its logical conclusion. The annualized results indicate the relationships of total economic impacts to basic economic impacts. That is, a multiplier is produced which indicates that one dollar of income to the export sector results in more than one dollar of income to the total economy. The Economic Impact Forecast System (EIFS) used by the Army Corps of Engineers is an economic base model.

b. Input-Output Models
In the 1950s input-output models were developed as an extension of economic base models.
These models generate multipliers to estimate employment, earnings, expenditures and output effects; and coefficients to allocate these effects to the sectors of the local or regional economy. Construction of unique regional models is time-consuming, expensive, and usually done by academics.
In recent years, analysts have come to rely on models derived from the national input-output data which is updated annually by the U.S. Department of Commerce. These models include the following: AIMS, used by the Army Corps of Engineers; IMPLAN, used by the Forest Service of the U.S. Department of Agriculture; REMI, from Regional Economic Models, Inc.; RSRI, from the Regional Science Research Institute; and RIMS, from the Bureau of Economic analysis of the U.S. Department of Commerce.
An extension of RIMS, called RIMSII, has been widely used since 1986 by consultants, researchers, and government analysts. Users include the U.S. Department of Defense (the impact of military base closings) and the Florida Department of Transportation (Developments of Regional Impact for major facilities). RIMSII multipliers are available for single counties, groups of counties, economic regions such as Metropolitan Statistical Area, individual states, and groups of states. RIMSII multipliers have also been incorporated into packaged models such as Arthur Andersen's Insight and Georgia Tech's LOCI.

c. Econometric Models
As with unique regional input-output models, econometric models are generally constructed and applied by academics. These models consist of a system of simultaneous equations that link economic activities such as consumption, production, investment, and wage and price determination. A recent example is the 1992 model of the economy of New Jersey devel

d. Economic Impact Analysis and Development Patterns
The state of the practice of economic impact analysis is that it is most commonly applied to site-specific projects such as conference centers, arenas and stadiums. The alternatives are often two -- without the project (the status quo) and with the project.
Another common application of economic analysis is as part of comprehensive and general plan updates. These analyses often document only the direct economic impacts due to new development. These include increases in employment as they relate to types of land use (office, industrial and retail/commercial). These analyses also tend to include impacts to their sponsoring local governments, such as increased retail space (sales tax revenues), and increased household incomes (local income taxes). Often these economic effects are calculated based on existing average sales per square foot and median household incomes. Therefore, to the extent that compact development results in the construction of fewer new homes or fewer new nonresidential square feet, its

direct economic impacts are likely to appear to be lesser in magnitude than those under sprawl.

Even using input-output multipliers and including indirect and induced impacts, economic analyses are blunt tools with which to compare compact and sprawl development. One reason for this is because most economic analyses are static, looking only at the impacts of new development in the base year and the buildout year. In a static economic analysis, the impacts of new development in the inner suburbs and urban core are likely to appear, not only of lesser magnitude, but also of lesser value than those in the outer suburbs.

Under current economic conditions, the most desirable land uses, and those located in the outer suburbs, are single family detached housing and suburban employment centers with free parking. These are the land uses that are accompanied by higher household incomes, higher retail sales per square foot, and often higher paying new jobs. Land uses associated with compact development, and with locations in the inner suburbs and urban core, are multifamily housing and high density employment centers accessed by transit. Under existing economic conditions, those land useobs.)

Econometric models, such as used for the analyses in the State of New Jersey and in Loudoun County, Virginia, are dynamic and consider interactions between growth and the economic base. As a result, they are more applicable to the situation in South Florida. These models can be used to look at the regional economy as a whole. They can consider the redistribution of households and jobs over time.

That is, if new development in the outer suburbs is discouraged, over time residential and employment locations in the urban core and inner suburbs are likely to become more desirable. As those locations become more desirable, market values, household incomes, and employment opportunities should increase. In other words, revitalization should take place. An analysis which considers the likely gradual increase in economic value of locations in the urban core and inner suburbs, is likely to permit a fair comparison of compact and sprawl development.

B. Economic Impacts on the Public Sector: Fiscal Impact Analysis

The measurement of economic impacts on the public sector is done most commonly through fiscal impact analysis. Fiscal impact analysis may be defined as follows:

"A projection of the direct, current, public costs and revenues associated with residential or nonresidential growth to the local jurisdiction(s) in which the growth is taking place." (Burchell and Listokin, 1978, p. 1.) Fiscal impact analysis may also be defined as cost-revenue analysis.

There are four basic steps of fiscal impact analysis:

Calculate the projected increases in population and employment due to growth;

Translate these increases into public costs;

Project the revenues due to growth; and

Compare costs to revenues.
The next section discusses the three recommended methodologies of fiscal impact analysis. The methods mainly differ in the techniques used to estimate public costs.

1. Recommended Methodologies
a. Per Capita Method
The most common type of fiscal impact analysis uses the per capita multiplier method. This means that a local government's current per capita costs are applied to the population generated by new development. Because this technique uses average costs, it should not be used where local public facilities or services are either under- or over-capacity.
The per capita method is often used by consultants and local government analysts, using custom-designed spreadsheets. Packages such as Arthur Andersen's Insight also use the per capita method.

b. Case Study Method
In the case study method, the analyst interviews local service providers. Through these interviews, information is obtained on the true marginal costs of serving the projected new development. This method is particularly appropriate when the capacity of costly public facilities, such as schools, is an issue.
Elements of the case study method may be included in otherwise largely average cost fiscal analyses done by local governments and many consultants. Marginal costs are often applied to capital facilities, based on available capital improvement programs (CIPs), engineering studies, and master plans for schools, parks and recreation, etc.. Some consultants attempt to apply the case study method in every analysis. Among this group is Tischler & Associates, Inc., which also holds the license for several fiscal impact models (MUNIES, FISCALS and CRIM).

c. Econometric Method
Elements of the econometric method may be included in either per capita or case study fiscal analyses. That is, where it is known that increases in local assessed value will result in lower shares of revenues distributed by states and counties, reductions in such revenues may be phased in over time. Dedicated use of the econometric method may make sense for large projects with long buildout periods. However, it requires significant setup time and is much more expensive to use. In the early 1990s an econometric model was developed by the Government Finance Research Center. It was implemented in one jurisdiction, but was difficult for staff to update and for citizens to understand. The econometric model developed for the State of New Jersey by Burchell et al also includes fiscal impact analysis.

d. Fiscal Impact Analysis and Development Patterns
Fiscal impact analysis is routinely included as part of the long range planning process at the local, regional and State levels. This type of analysis is a sharper

tool with which to compare patterns of land development than is traditional economic analysis.

Outputs of a fiscal impact analysis include costs for infrastructure which is sensitive to distance, such as water and sewer lines and roadways. These capital costs are likely to be lower under compact development patterns. Of course, some of these distance-sensitive capital costs are borne by the private sector. This includes the construction of local roads and connection to existing water and sewer systems. However, the public sector is usually responsible for part or all of construction or expansion of regional facilities, such as wastewater treatment plants, and water and sewer distribution lines. The need to construct or expand centralized facilities is often greater under sprawl than under compact land uses.

Other outputs of a case study, marginal cost fiscal impact analysis include costs for infrastructure which is sensitive to capacity. This includes school buildings and arterial and collector roadways. If existing systems have available capacity, these capital costs are also likely to be lower under compact development patterns. If existing systems do not have available capacity, and retrofitting is necessary (such as installing larger water and sewer pipes, or widening existing roads), infrastructure costs under compact development patterns may be significant.

To the extent that operating costs are associated with capital facilities which have existing capacity, they will tend to be lower under compact development than sprawl. However, recent research indicates that a number of other operating costs, such as public safety and traffic control, tend to increase with density.

A third output of fiscal impact analysis is revenues. Large proportions of public revenues are based on the market values of real property. To the extent that assumptions regarding consumer preferences and hence market values of new housing and workplaces are based on a snapshot of existing conditions, revenues may project out as higher under sprawl than under compact development. However, if the fiscal analysis is linked to econometric analysis, the assumptions driving revenues under compact development patterns may become more positive over time.

The final output of fiscal analysis is the net impact, or revenues minus costs. Fiscal analyses with revenue projections based on existing conditions may show that compact development generates lower net revenues, or even higher net costs, than sprawl. Fiscal analyses with revenue projections based on changing conditions over time are less likely to show net benefits to sprawl.

III. SOCIAL IMPACTS

The basic social impacts of changes in land use, such as population and employment, have long been documented by developers and their consultants and by government analysts. Indeed, economic, fiscal, traffic and transportation analysis cannot proceed without such projected impacts.

A broader look at social impacts has become more common in the years since passage of the National Environmental Planning Act (NEPA) in 1969.

Environmental Impact Statements (EISs) prepared to comply with NEPA include such social components as housing and historic and cultural resources. In states such as California and Florida, required Environmental Impact Reviews (EIRs) and Developments of Regional Impact (DRIs) also include social impacts.

To the extent that social impacts can be quantified, they are often included in the fiscal impact analysis of new development. That is, the demands that new population and employment place on public facilities and services may be considered social impacts. Once these demands are quantified, they may also be costed out and considered fiscal impacts. For example, new development usually generates the need for more police officers, for school buildings and teachers, and for parks and recreational facilities.

Beyond such direct impacts, social impact analysis theoretically should compare changes in the level of community well-being before and after the new development. "In practice, there is little agreement on the exact methodology to be followed and the variables to be evaluated in conducting a social impact analysis. This lack of agreement is especially apparent when it comes to ascertaining 'well-being,' which is recognized as an important component of the analysis, but one most difficult to quantify." (Burchell et al, pp. 88-89; italics added.)

Large-scale models of social impacts have been developed to look at Western boomtowns and other such projects. However, most of the information needed to conduct social impact analysis is either already available or can be collected by means of surveys. Results are not likely to be monetized.

Because of the difficulty of quantifying measures of social well-being, the Preview/Quickway model offered with the Development Impact Assessment Handbook includes only the direct impacts of growth on public facilities and services. The assumption is that "an individual's well-being improves when a larger number of that person's needs are satisfied." (Burchell et al, p. 90)

In the rest of this section, some qualitative social impacts are discussed.

A. Preservation of Historic and Cultural Resources

To comply with both NEPA and the National Historic Preservation Act of 1966, EISs must document impacts on historic and cultural resources. "Cultural" resources have been defined as historic, archaeological, native American and other resources which predate modern American culture. "Historic" resources are synonymous with historic properties which either are included in, or are eligible to be included in, the National Register of Historic Places.

The identification of affected resources is usually in the form of a survey by professional archaeologists and architectural historians. (Jain et al, pp. 291-294.) The value of these resources is normally not monetized.

B. Open Space, Parks and Recreation

One of the key components of quality of life for many people is the availability of open space, parks and recreational facilities. EISs and other development impact analyses routinely address this issue. EISs document whether or not the proposed project directly affects existing park lands. EISs and other analyses also include the developer's plans for the provision of parks, recreational facilities and open space. The existing levels of service (LOS) for parks and open space (acres per 1,000 population) and recreation (square feet of buildings per capita; tennis or basketball courts per 1,000 population, etc.) can then be compared to the proposed LOS after the new development is completed.

C. Environmental Design

More and more urban planners are attempting to measure citizens' opinions on environmental design. Techniques include Visual Preference Surveys, which are slide presentations used to elicit public responses to various design options. (Diamond & Noonan, p. 63.)

Since passage of NEPA, Federal agencies have developed techniques of Visual Impact Assessment. Prominent among these are the Bureau of Land Management of the U.S. Department of Interior and the U.S. Forest Service. These techniques are used by professionals in the field, to determine the significance or severity of changes in the quality of visual resources, due to changes in land use. (Smardon, pp. 171-172.)

D. Housing

The availability of housing is addressed in EIS, EIR and DRI analyses. Such housing analyses use locally available data and plans. In many states, local comprehensive plans routinely include housing elements. Local housing agencies are also required to issue annual updates to their Comprehensive Housing Affordability Strategy (CHAS) or consolidated plans, to comply with HUD regulations. (Bregman et al, p. 194.)

A housing analysis begins with an inventory of existing units, adding new housing to be built as part of the development project. The analysis should consider the needs of project employees, and the needs for housing affordable to both new residents and employees. If a development is projected to create demand for more affordable units than currently exist, the local government may seek mitigation measures.

E. Equity

Development impact analysis does not routinely consider who wins and who loses from changes in land use. One attempt at such analysis is the Community Accounting Matrix developed for the East Side of Buffalo, New York. The matrix is an extension of an input-output economic model. It includes details on the race, age, sex and income of households and workers. (This method is generally called a "social accounting matrix.") An analysis using the matrix found that a shift of $1 from manufacturing industries on the East Side to services industries elsewhere in Buffalo, resulted in a total decrease of $1.02 to East Side businesses. Also using the matrix, this same decline in $1 of income was allocated differently to the elderly, female-headed households, African-Americans, and others. (Cole, pp. 107-124.) This social accounting matrix has potential for application to social

impact analysis.
Another analysis addressing equity was entitled, "Jobs/Housing Balance for Traffic Mitigation," and was completed in 1985 by the Association of Bay Area Governments in San Francisco. The study examined the availability of affordable housing and the potential for employing local residents. It also surveyed traffic mitigation measures in the study area. California communities routinely address the issue of jobs/housing balance in their land use and transportation plans. Outside of California, this type of analysis has not been standardized.

F. Quality of Life
One problem with conducting social impact analysis is defining the baseline, or existing conditions. Once that is established, the impact of future changes can be compared and assessed.
One Florida jurisdiction developed a "community report card," or a set of indicators of quality of life. Since 1985, the City of Jacksonville has tracked its performance on the following: Education; Economy; Public Safety; Natural Environment; Health; Social Environment; Government/Politics; Culture/Recreation; and Mobility. (Gregory, p. 1.) Jacksonville is also beginning to compare these indicators across its 17 neighborhoods; the results will be published in an "equity index." (Andrews, p. 14.)
Researchers at the University of Texas developed similar local indicators of quality of life in a widely cited 1973 study. Indicators were measured using locally available data such as the following:
Economy - Retail sales per 1,000 population
Education - Average per pupil expenditures
Public Safety - Crime rates per 100,000 population
Transportation - Percent of street miles served by public transportation (Lyon, pp. 152-153.)

G. Social Impact Analysis and Development Patterns
Social impact analysis is an emerging field, but not yet an art. At the most basic level, its outputs serve as inputs to all other forms of development impact analysis. These outputs include population, school enrollment, and employment. These outputs are also linked to the inputs of fiscal impact analysis, as follows. Given current levels of service, population generates the need for police officers, firefighters, and other public staff and facilities; and schoolchildren generate the need for classroom space, teachers, and other school staff and facilities.
Beyond such direct social impacts, a comparison of development patterns might attempt to include measures of quality of life (QOL) through the use of community surveys. To date, such qualitative measures are not routinely included in development impact analysis. Communities are beginning to document their baseline level of well-being, however, as with the City of Jacksonville's QOL indicators.

IV. TRANSPORTATION IMPACTS

Transportation impact analysis is conducted at three different levels of complexity. For individual projects which are relatively small in scope, a traffic impact study is conducted. For projects and plans which are significant in scope, a transportation analysis takes place. Finally, efforts are underway to develop integrated models of the interactions between various dimensions of the urban environment, such as transportation, land use, and air quality. Each type of analysis is discussed below.

A. Traffic Impact Analysis

Since the 1960s, both local government analysts and consultants have conducted traffic impact studies based on travel forecasting. Basically, this method involves documenting conditions on the existing road network; estimating trips to be generated by the proposed new development; distributing the new trips on the road network; and comparing the levels of service (LOS) before and after the new development. If LOS have decreased significantly (that is, congestion has increased), mitigation measures are considered.

With the widespread use of personal computers and standard sources of data, traffic analysts have been able to automate their calculations. The Transportation Research Board's standards for LOS, the Highway Capacity Manual, are now accessed through computer software. The Institute for Transportation Engineers' Trip Generation manual contains data which analysts typically enter into their own spreadsheets. In Florida, State LOS standards and the Highway Capacity Manual have been combined into a system of linked worksheets.

There are also packaged models designed for traffic impact studies. These include SITE and SITE/TEAPAC. According to one transportation consultant, however, 90% of traffic impact studies are conducted using only the Highway Capacity Manual.

B. Transportation Analysis

Transportation planning models have been widely used since the late 1960s. They are gravity-based, four-step, travel forecasting models. These types of models are used by local governments as part of their long-range planning process. They are used by the Metropolitan Planning Organizations in regional transportation planning. And they are used by both the public and private sectors in evaluating major changes in land use, such as Florida's Developments of Regional Impact.

A good example of this type of model is FSUTMS, the Florida Standard Urban Transportation Model Structure. This model is maintained by the Florida Department of Transportation, and used by most of the MPOs throughout the State. This model has evolved from the PLANPAC system developed by the Federal Highway Administration, and the UTPS system developed by the Federal Transit Administration (then UMTA).

Transportation planning analysis follows the same basic steps as traffic impact analysis. The difference is that a model is used to estimate trip generation, to distribute trips by location, time of day, and mode of transit, and to compare LOS before and after the proposed land use changes.

A shortcoming of the traditional transportation planning models is that they were designed to include only motorized travel, or trips by auto and transit. They were also designed to vary residential location but to assume employment location as fixed. In the next section, attempts to address these shortcomings are discussed.

C. Integrated Models

1. Linking Land Use and Transportation

a. ITLUP

An early model which links land use and transportation is ITLUP, or the Integrated Transportation Land Use Package. It was developed at the University of Pennsylvania in the 1970s, and has been continually expanded and improved. ITLUP has been calibrated for many metropolitan areas in the U.S. Real-world applications include land use projections for the Kansas City area, and transit investment options in Seattle and Houston. (Giuliano, p. 319.)

b. LUTRAQ

A well-known and recent attempt to integrate land use and transportation is the LUTRAQ project in Portland, Oregon. LUTRAQ, an acronym for Land Use, Transportation and Air Quality, arose in 1991 in response to a proposed Western Bypass in Portland. A state growth management organization, 1000 Friends of Oregon, contracted with consultants to examine alternatives to construction of the new highway.

The consultants developed projections based on transit-oriented development (moderate density, mixed uses, and pedestrian friendly design). They also included nontraditional transportation improvements, such as pedestrian and bicycle facilities and a Transportation Demand Management (TDM) package. The LUTRAQ alternative was selected by the Oregon Department of Transportation to be included in the environmental impact statement (EIS) for the proposed Western Bypass, required by the National Environmental Protection Act (NEPA). The project has issued reports on the Bypass analysis and on an alternative Countywide land use and transportation plan. LUTRAQ also serves as a resource to other communities in modifying their planning practices.

c. CUFM

Other areas of the country are experimenting with improvements to their ability to link land use forecasts to transportation modeling. One example is the California Urban Futures Model (CUFM). Developed at the Institute of Urban and Regional Development at the University of California, Berkeley, CUFM uses detailed land information in map form generated by a geographic information system (GIS). (Wegener, p. 24.) The model projects the demand for housing units in each jurisdiction in a region; identifies sites where projected units could be developed, given existing zoning, infrastructure and environmental constraints; and estimates future population growth. (Diamond & Noonan, p. 34.) However, CUFM does not model congestion, or include the regional transportation network. (Wegener,

p. 22.)

d. STEP

Another model developed in the Bay area was originally called TRIPS, and is now called STEP. Like CUFM, it does not include the regional transportation network. However, STEP analyzes travel demand and activity using the individual or household as the unit of analysis. It considers variation in location of residences and jobs, and in trip frequencies, destinations and mode choices. STEP's outputs can be disaggregated by income level or age. (Harvey, pp. 1-2.) STEP is now being used by transportation planners at Portland's Metropolitan Service District, and elsewhere in the U.S.

2. Linking Land Use, Transportation and Air Quality

As yet, there are no models which integrate impacts on land use, transportation and air quality. Research is currently under way to improve our ability to model vehicle emissions. Such improvements are being motivated by the 1990 Clean Air Act Amendments (CAAA) and the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). These require that regional transportation plans conform with their State Implementation Plans (SIPs) for air quality management. Currently, air quality models are run by State agencies. Outputs of the air quality models are treated as inputs or caps to the regional transportation planning models. That is, in order to conform to standards for clean air, regions must attempt to reduce projected vehicle miles traveled (VMT). In order to reduce VMT, adjustments are made to the assumptions used in the transportation planning models.

The Travel Model Improvement Program, jointly funded by the U.S. Department of Transportation and EPA, is sponsoring the development of the Transportation Analysis Simulation System (TRANSIMS). This is a system of linked models designed to be interactive. Its traffic simulation component is now being tested in the Dallas-Ft. Worth region. Its trip planning component will be tested in the Portland region later in 1997. Its air quality component is yet to be developed. (Wormser, p. 14.)

D. Transportation Impact Analysis and Development Patterns

The state of the practice of transportation impact analysis is as follows. Analyses are regularly included as part of the long range planning process at the local, regional and State levels. Outputs of these analyses include Average Daily Trips, Vehicle Miles of Travel, and Levels of Service (LOS) on the existing road network.

Assuming a decline in LOS due to the traffic generated by new development, transportation planners and engineers can specify a range of mitigating improvements. They can also estimate the cost of these improvements. The reader should note that these last two steps -- determination of improvements to capacity, and estimating improvement costs -- are outside of most transportation planning models.

That is, traditionally, neither traffic impact studies nor transportation planning models generated results expressed in dollars. Rather, their results were expressed in trip volumes, vehicle miles of travel, and amounts of traffic congestion (declines in LOS). The analysis had to be extended to determine how much additional highway capacity was needed, usually expressed in lane miles, intersection improvements, etc.. An additional step was then required to attach costs to the needed capacity improvements.

The Preview/Quickway model offered with the Development Impact Assessment Handbook attempts to address that shortcoming. It calculates needed expansions to highway capacity and associated costs. However, Preview/Quickway does not distribute trips based on a gravity model, but rather on the assumption of equal directional distribution. As a result, it oversimplifies trip distribution.

The results of transportation impact analysis tend to be more favorable for compact development patterns than for sprawl. An example is the LUTRAQ analysis as reported in a 1995 article. Compared to the construction of the Western Bypass (and continued suburban sprawl), the LUTRAQ alternative resulted in a 13.6% decrease in vehicle miles traveled and a 7.7% decrease in vehicle hours traveled (both for p.m. peak). LUTRAQ also showed a 3.7% decrease in average autos per household and an 8.1% decrease in total daily vehicle trips per household.

Non-construction of the proposed Bypass, however, resulted in a 16.8% increase in vehicle hours of delay for the LUTRAQ alternative. In addition, the author found that, " ... land use policies appear to have little impact on travel outcomes; most of the observed change results from the TDM (Transportation Demand Management) policies." (Giuliano, p. 326.) These policies included the assumptions that all workers in the study area had free access to transit, and that parking was not free but cost one-third of that in downtown Portland. (Giuliano, p. 323.)

The author also found that "the magnitude of change in land use patterns for the LUTRAQ alternative is large.... These results are also consistent with other simulation studies of density and trip characteristics that find dramatic increases in development density are required to affect mode share and trip length significantly." Finally, the author found that "... the magnitude of the investment in transit service is large compared to the resulting changes in mode share." (Giuliano, p. 326; emphasis added.)

In short, compact development patterns may be associated with fewer new miles of highway construction and lower vehicle miles of travel. However, as with economic and fiscal impact analysis, if the assumptions of transportation impact analysis are rooted in today's market realities, their outputs may not show significant advantages to compact development. In order to show significant advantages to compact development modelers may need to assume major changes over time, in consumers' desires to live and work in low density settings, drive single occupancy vehicles, and receive free parking.

V. ENVIRONMENTAL IMPACTS

Environmental impact analysis became a formal discipline with the enactment of the National Environmental Policy Act (NEPA) in 1969. This type of analysis has been defined as the "systematic identification and evaluation of the potential impacts (effects) of proposed projects, plans, programs, or legislative actions relative to the physical-chemical, biological, cultural and socioeconomic components of the environment." (Burchell et al, 1994, p. 67.)

While NEPA is primarily directed toward actions by the Federal government or projects eligible for Federal funding, environmental impact analyses are also undertaken as a result of State and local review requirements. Burchell et al report that over 20 states have "mini-NEPAs," which require environmental impact assessments of changes in land use. Environmental reviews have also become important at the local level, in conjunction with land use planning, permitting and zoning requirements.

In actual practice, environmental impact analysis covers a wide range, including impacts discussed earlier in this paper, such as economic, social and transportation. To the extent that specific environmental impacts are discussed in this section of the paper, they are ecological impacts, or impacts related to natural resources.

A. Analysis of Pollution

Among the most commonly analyzed environmental impacts are pollution in various forms. Specialized models have been developed to analyze different pollution effects.

1. Air Quality

As discussed above under Transportation Impacts, evolving Federal laws are requiring improvements in our ability to predict emissions from mobile sources such as vehicular traffic. Currently, most analysts use EPA's MOBILE model, which includes emission rates from a sample of vehicles. (Garrett and Wachs, p. 24.) Emissions from mobile sources in turn serve as inputs to models of air quality, along with emissions from area sources and emissions from point sources. (Wayson, pp. 102-103.)

The most common application of air quality analysis is through the Urban Airshed Models generally run by State Departments of Environment. Urban Airshed Models are used in monitoring attainment with Federal air quality standards. For subregional level analyses, Counties also monitor air quality and can provide data regarding existing conditions.

Measurements of air quality are usually expressed in terms of pollutants such as hydrocarbons, nitrogen oxide, and carbon monoxide. (Morris and Therivel, pp. 133-139.) These measures can be used to compare the baseline or existing conditions to predicted conditions after buildout of a development project or a proposed land use plan. Assuming an increase in air pollution, mitigation measures can then be considered.

2. Water Quality

Factors affecting water quality include both point and non-point sources of pollution. Point sources are usually associated with industrial process, wastewater treatment, and other closely regulated land uses. An important non-point source of water pollution is stormwater runoff, which is discussed further below. (Morris and Therivel, p. 192.)

Modeling of water quality is done by State and County departments of environment and health and local water authorities. Water quality modeling is also conducted by hydrologists in academia and consulting, and by Federal agencies such as EPA, the Department of Interior, and the Army Corps of Engineers. The Corps is currently working with EPA, the South Florida Water Management District, and others on hydrodynamic modeling of the Everglades.

Measurements of water quality may be expressed in terms of sediment load, turbidity, and oxygen levels. Commonly measured water pollutants include nutrients, biocides, organics, heavy metals, and pathogens. (Morris and Therivel, pp. 188-189.)

Baseline measures or existing conditions of water quality may be compared to predicted conditions after buildout of the project or plan. Assuming an increase in water pollution, mitigation measures can then be considered.

3. Noise

Noise pollution is generated by such land uses as highways, airports, and heavy industry. Most environmental impact analyses include estimates of projected noise levels from the proposed new development. Computerized models of noise contour analysis may be used, or existing conditions may be compared to published estimates by types of land use. The U.S. Department of Housing and Urban Development has developed Noise Assessment Guidelines based on traffic data. (Burchell et al, 1994, p. 80.)

4. Stormwater Runoff

One measure of "land pollution" is soil erosion; erosion in turn is heavily influenced by rainfall and storm frequency and intensity. (Morris and Therivel, p. 157.) A related subfield of environmental impact analysis, with a specialized set of analysis techniques, is the study of stormwater runoff. Analysis of stormwater runoff is particularly relevant to compact versus sprawl development, due to the smaller amount of impervious surface associated with the former.

A recent report compared five techniques of stormwater analysis for watersheds in West Central Florida. These techniques are listed below.

The Rational Method - Useful for comparing changes in land use. Recommended for watersheds with drainage areas less than five square miles in size. Simple and easy to use.

Regional Regression Equations of the U.S. Geological Survey - Recommended for watersheds with no significant urban development.

Natural Resources Conservation Service model - Widely applicable; can be calculated manually.

HEC-1 (Hydraulic Engineering Center-1) model of the Army Corps of Engineers

SWMM (Storm Water Management Model) of the EPA

The latter two models are the most complex and difficult to use. (Trommer et al, pp. 6-16.)
Measurements of stormwater runoff are usually expressed in terms of peak discharges and runoff volumes. In a recent analysis of the Harbor Watershed in Charleston, South Carolina, a comparison of two land use patterns found that sprawl generated a 43% higher volume of stormwater runoff than more compact development. The study also found that compact development generated fewer adverse impacts on water quality. (Jones Ecological Research Center. Charleston Harbor Project. Columbia, S.C.: State Department of Health and Environmental Control, 1996.)

B. Carrying Capacity
Carrying capacity may be defined as the natural and manmade limits to development, beyond which harm will occur. Carrying capacity analyses have been conducted in a number of Florida jurisdictions. On Sanibel Island, carrying capacity was defined to include the number of people who could be evacuated in the case of a hurricane. This manmade limitation on coastal development is being used to limit the location and quantity of growth on the island. Those limits in turn are reducing the hazards associated with thunderstorms and other natural disasters. (Beatley et al, pp. 164-165.)
Environmental impact analysis of specific projects typically includes elements of a carrying capacity analysis. That is, the baseline is documented for elements such as water supply, wastewater treatment and solid waste capacity. Future demands by new population and employment, expressed in gallons of water and sewage and tons of solid waste, are then estimated. Those demands are compared to plans for expansion of water, wastewater and solid facilities, to determine if capacity will be adequate. If projected future capacities are not adequate, mitigation measures are considered. These pieces of the analysis can often be conducted using existing studies and other locally available data.

C. Ecology
Ecological impact analysis includes what used to be called flora and fauna, and now may be referred to as wildlife and vegetation, or species and habitats. This is an emerging field.
Ecological impacts are commonly evaluated based on magnitude and on the value of the affected systems. Measures of magnitude include acres of land with either lost or fragmented habitat, and numbers of species populations or communities lost due to development. Species are valued based on conservation status, role of the species, amenity value, rarity, and local, national and international importance.

Ecosystems are valued based on the habitats and communities located there, larger ecosystems usually being associated with greater biodiversity. Ecosystems are also valued based on their naturalness, rarity or typicalness, and fragility or sensitivity.
Ecological evaluation techniques include priority rankings, habitat evaluations, and composite indexes. Large scale analyses sometimes include monetary values, economic benefits, and replacement values assigned to ecological resources. Entire types of ecosystems, or biomes, have also been simulated by means of computer models. However, the typical ecological analysis is more likely to use information from existing studies and expert opinion. (Morris and Therivel, pp. 217-222.)

D. General Analysis Techniques
As the above topics indicate, environmental impacts cover a broad range. Beginning in the 1970s, a number of techniques have been developed to analyze this range. Five types of techniques are discussed below.

1. Checklists and Matrices
Checklists are one-dimensional lists of potential impacts. They may be expanded to two-dimensional matrices by listing a range of actions along the second axis. One of the better known matrices was prepared by Leopold et al in 1971 for analysis of the impacts of construction projects. The Leopold matrix has a maximum of 8,800 cells. A ten-point scale is used to score levels of impact, both positive and negative. The results of such large matrices may be summarized into "grand indexes." This is done by summing positive and negative cell contents, and even weighting cells, rows, or columns to achieve a net result.
The advantage of a grand index is its ability to summarize large amounts of data for decision-making. The disadvantage is that the relative contributions of different elements and actions are obscured. (Westman, pp. 133-142.)

2. Weighting-Scaling Techniques
Analysts have been concerned that the grand indexes which summarize matrices combine both empirical observation and normative judgment. They have therefore developed techniques that make explicit the basis for ratings and scales. Among the best known of these weighting-scaling techniques is the Environmental Evaluation System (EES). This was developed at Batelle Laboratories for use with water resources projects. The EES measures the impact of actions on 78 components of the environment. Those values are then converted to common units using scalars. The resulting scaled impacts are then weighted by importance values, and the final products summed to calculate a grand index. The index may then be compared to a grand index calculated for the baseline, or existing conditions.
Use of the EES requires development of new scalars for each project. This in turn requires extensive baseline data. Weighting of the scaled impacts further relies heavily on expert opinion. The resulting "numbers have the patina of

scientific respectability" due to "burial of subjective judgment within numerical scores." (Westman, pp. 149-152.)

3. Distributional Techniques

Several other techniques document the distribution of impacts among affected groups. These include the Planning Balance Sheet and the Goals Achievement Matrix. Both of these techniques require that impacts be expressed either in monetary terms or in physical units.

A promising distributional technique is the Simple Tradeoff Matrix. This shows the environmental impacts on affected groups, as costs and benefits expressed in both qualitative and quantitative measures. The advantage to this type of matrix is that it leaves the assignment of weights to decision makers. The disadvantage is the size of the resulting matrix, and the difficulty of summarizing net benefits and costs. (Westman, pp. 155-162.)

4. Monetary Valuation

The Army Corps of Engineers has conducted cost-benefit analyses of the water resources projects under its domain since the 1930s. These analyses have focused on the value of such projects to economic production and economic development. The Corps is now seeking more of an equilibrium between economic and environmental impacts. Toward that end, it is conducting a multi-year Research Program, entitled the Evaluation of Environmental Investments (EEIRP).

A February 1995 report from this program lists a number of monetary valuation methodologies, " ... including market-based, surrogate market, and nonmarket techniques. The market-based techniques include changes in factors of production and next best alternatives. Surrogate market techniques include the travel cost method and hedonics. Finally, among the nonmarket techniques are the contingent valuation method....." (Feather et al, pp. 3-5.)

Throughout the report, multiple authors point out the limitations on monetary valuations and cost-benefit analyses as tools for environmental decision making. These include "the (misleading) implication that they carry a 'right' answer" (p. 15); the fact that "There is no clearly dominant approach" (p. 23); and the "difficulties with assigning monetary values to environmental resources" (p. 46).

A definitive criticism is the following: "While many papers and books are available on benefit-cost analysis, there is a dearth of good data available on rigorous attempts to quantify these environmental impacts....the conceptual models are excellent, but the quality of the applications is lacking due to lack of rigorous data base development." (p. 107.)

The Corps report also places cost-benefit analysis in historical perspective: "The role of benefit computations has not been to establish values, but rather to serve as a starting point in negotiations over value. This kind of negotiation went on when the value of drainage works was negotiated in the 1850s, and 150 years later value estimates are serving negotiations over the values lost when natural resources are damaged. To expect value estimation to be any more than another 'argument' introduced into public deliberations is to ignore this history." (p. 161)

The report's introduction also places these tools in the context of the public decisionmaking arena, using 1990s terminology: "Monetary valuations and nonmonetary evaluations are intended to serve as inputs to environmental investment decision processes. Final environmental investment decisions typically are reached via implicit or explicit trade-off analyses and negotiations between the various stakeholders." (Feather et al, pp. 3-5.)

5. Geographic Information Systems

Analysts are making more and more use of Geographic Information Systems (GIS) in environmental impact analysis. Information stored in GIS data bases can be used to map existing conditions. Projected changes can then be overlaid on the baseline data, to map expected future conditions.

The Army Corps of Engineers uses GIS and coincidence and conflict models to analyze soil types, slope, noise, species, habitats, vegetation, and wetlands, among other applications. Parameters outlining negative impacts are set (for example, noise levels above 65 decibels) and compared to baseline data and future conditions. Maps are then prepared, showing the magnitude and geographic ranges of any negative impacts.

Another example of the use of GIS in environmental impact analysis is a model called CITYgreen. Developed by the conservation organization American Forests, this model uses aerial photography to create a digital map of the tree canopy. Reductions in the tree canopy are usually associated with increases in stormwater runoff, energy consumption and air pollution.

Another GIS model, INDEX, uses GIS to map "livability indicators," ranging from the presence of open space to the volume of water and energy consumption. It is intended for evaluation of alternative plans or projects. INDEX was developed by Criterion Engineers & Planners in Portland, Oregon.

E. Environmental Impact Analysis and Development Patterns

In this paper environmental impacts are focused on natural resources such as air, water, soil, species and habitats. Generally, compact development will result in lower consumption of natural resources and fewer negative environmental impacts.

These impacts can be measured in terms of acres of open space, wetlands, and wildlife habitats either lost or preserved. Impacts can also be measured in terms of levels of pollutants in the air and water, volumes of stormwater runoff, and decibels of noise. Finally, impacts can be compared to the carrying capacity of natural and related manmade systems, such as water, wastewater and solid waste.

Most environmental impact analysis is conducted as follows. Baseline conditions are documented and compared to expected future conditions after buildout of the proposed project or plan. Baseline conditions are often documented through the use of surveys and previously commissioned studies. Future conditions are often estimated based on existing data bases which link environmental impacts to types of land use. Comparison of baseline to future conditions may be through checklists, matrices, and indexes. More and more, comparisons are made by

maps produced using Geographic Information Systems (GIS).
Baseline and future conditions are expressed in different units of measurement, depending upon the type of impact. In other words, environmental impacts (like social impacts) are measured in apples and oranges. Analysts have attempted to construct techniques and models which permit the comparison of apples and oranges, and even their valuation in monetary terms. However, the use of such techniques and models "prevent(s) the public and decision makers from following the steps in reasoning and challenging judgments." Or, to continue with the analogy, "it is easier for a decision maker to apply his or her own weights to apples and oranges when they are presented as such, than when they have both been scaled to some organic fruit using panel(s) of experts ...." (Westman, p. 163.)
On the other hand, while documenting baseline conditions and estimating future conditions can be performed by the average analyst, evaluating the significance of impacts is best done by a team of seasoned professionals with expertise in the various environmental subfields. These include hydrology, biology, ecology, geology, and other disciplines. (Morris and Therivel, p. 217.)

REFERENCES

ECONOMIC IMPACTS

Burchell, Robert W., and David Listokin. The Fiscal Impact Handbook. New Brunswick, New Jersey: Rutgers University, Center for Urban Policy Research, 1978.

Burchell, Robert W., David Listokin, and William R. Dolphin et al. Development Impact Assessment Handbook. Washington, D.C.: Urban Land Institute, 1994.

Crihfield, John B., and Harrison S. Campbell, Jr. "Evaluating Alternative Regional Planning Models." Growth and Change, Spring 1991, pp. 1-6.

Jain, R.K., L.V. Urban, G.S. Stacey, and H.E. Balbach. Environmental Assessment. New York: McGraw-Hill, 1993.

Malizia, Emil E., and Robin A. Howarth. The Governors Club Development Impacts. Chapel Hill: Institute for Economic Development, Department of City and Regional Planning, University of North Carolina, 1996.

Muller, Thomas. "Assessing the Impact of Development." Environmental Comment, October 1976.

Tischler & Associates, Inc., Bethesda, MD. Personal communications with Paul Tischler and Jeffrey Bronow, March 1997.

SOCIAL IMPACTS

Andrews, James H. "Going by the Numbers." Planning, September 1996, pp. 14-18.

Association of Bay Area Governments. Jobs/Housing Balance for Traffic Mitigation: Interstate 608 and Interstate 580 Corridor Study. San Francisco: ABAG, 1985.

Bregman, Jacob I. And Kenneth M. Mackenthun. Environmental Impact Statements. Boca Raton: Lewis Publishers, 1992.

Burchell et al, Development Impact Assessment Handbook, op. cit.
Cole, Sam. "A Community Accounting Matrix for Buffalo's East Side Neighborhood." Economic Development Quarterly, November 1996, pp. 107-125.

Diamond, Henry L., and Patrick F. Noonan. Land Use in America. Washington, D.C.: Island Press, 1996.

Gregory, Michelle. "Defining and Measuring Quality of Life." PAS Memo, August 1996, pp. 1-4.

Jain et al, Environmental Assessment, op. cit.

Lyon, Larry. The Community in Urban Society. Philadelphia: Temple University Press, 1987.

Smardon, Richard C., Editor. The Future of Wetlands: Assessing Visual-Cultural Values. Totowa, NJ: Allanheld, Osmun Publishers, 1983.

Wegener, Michael. "Operational Urban Models: State of the Art." Journal of the American Planning Association, Winter 1994, pp. 17-29.

TRANSPORTATION IMPACTS

Bachle, Laura, and Chris Winters. "The Link Between Land Use and Air Quality." Environmental Planning Quarterly, Spring-Summer 1994, pp. 6-10. Also personal communication with Laura Bachle, March 1997.

Bartholomew, Keith A. "Making the Land Use, Transportation, Air Quality Connection." PAS Memo, May 1993, pp. 1-4.

Burchell et al, Development Impact Assessment Handbook, op. cit.

Diamond and Noonan, Land Use in America, op. cit.

Ferguson, Erik. "Transportation, Land Use and Air Quality." Environmental Planning Quarterly, Spring-Summer 1994, pp. 11-15 and 31.

Florida Department of Transportation, Office of the State Transportation Planner, Systems Planning Office. Personal communication with Terrence Corkery, March 1997.

Garrett, Mark, and Martin Wachs. Transportation Planning on Trial: The Clean Air Act and Travel Forecasting. Thousand Oaks, CA: Sage Publications, 1996.

Giuliano, Genevieve. "Land Use Impacts of Transportation Investments: Highway and Transit." In The Geography of Urban Transportation, edited by Susan Hanson. New York: The Guilford Press, 1995, pp. 305-341.

Harvey, Greig. The STEP Analysis Package: Description and Application Examples. November 10, 1995. Draft provided by Michael Replogle, Environmental Defense Fund.

KFH Group, Inc., Bethesda, MD. Personal communication with Fred Fravel, March 1997.

LUTRAQ Update: Making the Land Use, Transporation, Air Quality Connection. Vol. 1., No. 4., November 1992, pp. 1-4.

Pflum, John E. "Traffic Impact Studies." Land Development, Fall 1993, pp. 25-29. Also personal communication with Jack Pflum, March 1997.

Wegener, "Operational Urban Models," op. cit.

Wormser, Lisa, "Travel a la Mode." Planning, February 1997, pp. 10-14.

ENVIRONMENTAL IMPACTS

Beatley, Timothy, David J. Brower and Anna K. Schwab. An Introduction to Coastal Zone Management. Washington, D.C.: Island Press, 1994.

Bregman and Mackenthun, Environmental Impact Statements, op. cit.

Burchell et al, Development Impact Assessment Handbook, op. cit.

Feather, Timothy D., Clifford S. Russell, Keith W. Harrington, and Donald T. Capan. Review of Monetary and Nonmonetary Valuation of Environmental Investments. Alexandria, VA: U.S. Army Corps of Engineers, Water Resources Support Center, Institute for Water Resources, February 1995.

Garrett and Wachs, Transportation Planning on Trial, op. cit.

Morris, Peter, and Riki Therivel. Methods of Environmental Impact Assessment. London: UCL Press, 1995.

Jain et al, Environmental Assessment, op.cit.

Trommer, J.T., J.E. Loper, and K.M. Hammett. Evaluation and Modification of Five Techniques for Estimating Stormwater Runoff for Watersheds in West-Central Florida. Tallhassee, Florida: U.S. Geological Survey, 1996.

U.S. Army Corps of Engineers, Construction Engineering Research Laboratory. Personal communication with Hal Balbach, March 1997.
U.S. Army Corps of Engineers, Office of Chief of Engineers, Division of Research and Development, Civil Works. Personal communication with Dr. Bill Roper, March 1997.

U.S. Army Corps of Engineers, Waterways Experiment Station, Information Technology Laboratory. Personal communication with Tim Abells, March 1997.

Wayson, Roger L., Editor. Transportation Planning and Air Quality. New York: American Society of Civil Engineers, 1992.

Westman, Walter E. Ecology, Impact Assessment and Environmental Planning. New York: John Wiley & Sons, 1985.

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